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Research Note

Endoparasites of Beaver (*Castor canadensis*) from Kansas

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ABSTRACT: A survey was conducted to determine the endoparasite fauna of *Castor canadensis* populations in 3 counties in northeast and eastcentral Kansas. During the 1990 trapping season, 63 skinned beaver carcasses were provided by local trappers for parasitological examination. Six species of parasites were found: 2 protozoans, *Eimeria sprehni* Yakimoff, 1934, and *E. causeyi* Ernst, Cooper, and Frydendall, 1970; 1 digene, *Stichorchis subtriquetrus* (Rudolphi, 1814); and 3 nematodes, *Travassosius americanus* Chapin, 1925, *Dracunculus* sp., and *Baylisascaris* sp. This is the first report of *Dracunculus* sp. and *Baylisascaris* sp. from North American beavers.

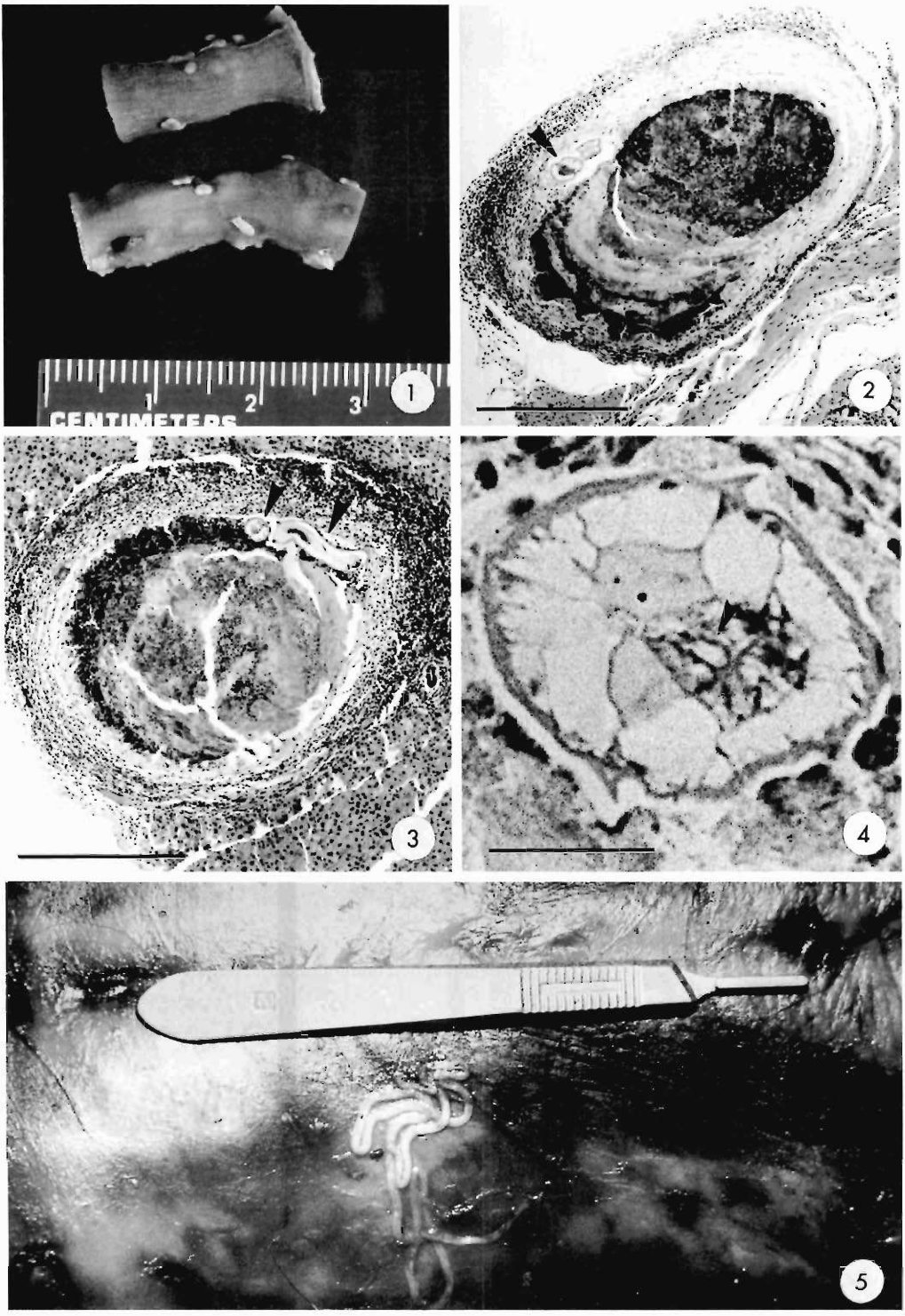
KEY WORDS: beaver, *Castor canadensis, Eimeria sprehni, Eimeria causeyi, Stichorchis subtriquetrus, Travassosius americanus, Dracunculus* sp., *Baylisascaris* sp., Kansas, histopathology, eosinophilic granuloma.

The beaver, *Castor canadensis* Kuhl, is the largest member of the order Rodentia found north of Panama (Hall, 1981), with exceptional individuals weighing as much as 44 kg (Bee et al., 1981). Beaver have one of the most extensive and varied distributions of any North American mammal and inhabit most of the continental United States, Canada, and Alaska, from as far north as the Brooks Range and south to the states of Nuevo Leon and Tamaulipas, Mexico (Hall, 1981; Nowak and Paradiso, 1983).

Reports of the parasite fauna of beaver date to 1669 (see Lawrence and Graham, 1955, for review). However, the majority of reports (21/29), where the collection site of the host is given, have been made above 40°N latitude. Thus, little information is available on the protozoa or helminths of beavers from the mid- to southern areas of its range. Studies conducted below 40°N latitude are from Alabama (Ernst et al., 1970), Colorado (Olsen, 1949), Louisiana (Bennett and Humes, 1939), Mississippi (Foil and Orihel, 1975), Texas (Fedynich et al., 1986), and Virginia (Ogburn-Cahoon and Nettles, 1978). To the best of our knowledge, no comprehensive study has been undertaken to examine the parasite fauna of beavers from the central United States. Consequently, the following study was initiated to determine the endoparasites of various beaver populations from northeastern and eastcentral Kansas.

Between 2 February and 18 March 1990, 63 skinned beaver carcasses were received at the Department of Veterinary Diagnostic Investigations, Kansas State University. Trappers acquired animals from 5 different sites from 3 counties: 6 animals from Lyon County (along a section of the Neosho River between 38°24′N, 96°09′W, and 38°22′N, 96°06′W), 2 from Pottawatomie County (Cedar Creek between 39°17′N, 96°33′W and 39°16′N, 96°32′W), and 55 from 3 localities in Riley County (the Kansas River between 39°05′N, 96°42′W, and 39°07′N, 96°39′W; the Blue River between 39°30′N, 96°39′W, and 39°32′N, 96°37′W; and Wildcat Creek between 39°13′N, 96°42′W, and 39°12′N, 96°42′W). Carcasses were presented within 48 hr of trapping, with none having been frozen prior to examination. Upon receipt, all specimens were sexed and weighed, and a total length measurement was taken. Each carcass was examined grossly for the presence of any tissue-dwelling parasites, obvious lesions, or deformities. Although necropsies were performed on all 63 animals, tissues were collected from the first 42 only and placed in 10% buffered neutral formalin for later histologic examination.

Gastrointestinal tracts were removed intact from all 63 beavers. Viscera were separated into stomach, small intestine, cecum, large intestine, and rectum. The mucosal surface of the duodenum from 20 animals was scraped with a scalpel blade, and the scrapings were examined as squash preparations for *Giardia* sp. using Nomarski interference contrast optics (Upton et al., 1991). A fecal sample was then removed from the rectum



Figures 1–5. ***Baylisascaris*** **sp. larvae and** ***Dracunculus*** **sp. from Kansas beavers. 1. Formalin-fixed sections of small intestine with nodules, each nodule containing a single** ***Baylisascaris*** **sp. larva. 2. Photomicrograph of**

of 59 animals and placed individually in 2.5% (w/v) aqueous potassium dichromate ($K_2Cr_2O_7$) solutions for protozoal examination. Gut sections were split lengthwise and the contents washed into separate containers, after which mucosal scrapings of the wall of each section were collected and added to the contents of each respective container. The combined mucosal scrapings and free gut contents were then washed, using cool tap water, through a graded series of sieves, with exclusion sizes of 2 mm, 850 μm, and 425 μm, respectively (Fisher Scientific, St. Louis, Missouri). Contents of each sieve were examined grossly and with the aid of a dissecting microscope, and any parasites seen were removed and placed in tap water. All nematodes were fixed in hot alcohol–formalin–acetic acid (AFA) and then stored in 70% ethanol. Trematodes were allowed to relax and die in water and then were fixed and stored in AFA. Voucher specimens of helminths recovered in this study have been deposited in the U.S. National Helminthological Collection (Beltsville, Maryland 20705, U.S.A.): *S. subtriquetrus,* 82813; *T. americanus,* 82814; *Dracunculus* sp., 82816; *Baylisascaris* sp., 82815. Paraffin blocks of liver and small intestine containing *Baylisascaris* sp. larvae have been deposited in the Armed Forces Institute of Pathology (Washington, D.C. 20306, U.S.A.): 2401031.

Feces were examined following flotation in a modified Sheather's sugar solution (specific gravity 1.30). Samples positive for coccidian oocysts were placed in petri dishes in a thin layer of 2.5% $K_2Cr_2O_7$ and allowed to sporulate for 1 wk at room temperature (23°C). Samples were subsequently reexamined using Nomarski interference contrast microscopy. All oocysts were measured within 10 days following sporulation.

Of the 63 beavers examined, 57 (91%) harbored 1 or more species of 6 parasites. These included 2 protozoa (parasite followed by number of hosts infected/percentage of hosts infected), *Eimeria sprehni* (16/25%) and *Eimeria causeyi* (3/5%); 1 digene, *Stichorchis subtriquetrus* (56/89%); and 3 nematodes, *Travassosius americanus* (23/35%), *Dracunculus* sp. (2/3%), and a larval *Baylisascaris* sp. (1/2%). No trophozoites or cysts of *Giardia* sp. were seen in any of the duodenal or fecal samples examined. The majority, 49 (86%) of the 57 animals positive for parasites, were found to be infected by 1 (23/37%) or 2 (26/41%) parasite species. Of the 8 animals remaining, 7 (11%) had 3 parasites and 1 (2%) had 4 different species. Interestingly, of all 57 infected animals, 56 (98%) harbored *S. subtriquetrus.* The exception was a single animal infected only with coccidian *E. sprehni.* Of the 19 animals shedding coccidial oocysts, 18 (95%) had monospecific infections, with *E. sprehni* and *E. causeyi* accounting for 16 and 2 infections, respectively. One animal shed oocysts of both *Eimeria* species.

An adult 18-kg female taken from Cedar Creek, Pottawatomie County, had numerous small (1–2 mm), white raised nodules scattered over the serosal surface of the liver, small intestine, and colon (Fig. 1). One nodule was removed and compressed between 2 glass slides as a squash preparation. Microscopic examination under low power (100×) revealed a vigorously undulating nematode larva. Histopathological examination of sections of small intestine and liver containing nodules showed demarcated and slightly encapsulated masses (Figs. 2, 3). The center of each nodule was eosinophilic, caseous material with abundant cellular debris. Peripheral to the caseous center was a layer of macrophages with some multinuclear cells. The outer layer of inflammation had numerous eosinophils with a few neutrophils, macrophages, lymphocytes, plasma cells, and fibroblasts. Cross-sections and oblique sections of a nematode larvae at the interface of the cellular layer and caseous core could be seen (Fig. 4). Microscopic and gross morphological characteristics of these larvae, as described by Bowman (1987), led to a tentative diagnosis of *Baylisascaris* sp. Positive identification of the larva as *Baylisascaris* sp. was made by Dr. Kevin R. Kazacos of Purdue University (West Lafayette, Indiana).

Two female beavers, 1 5.5 kg and the other 14

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intestinal lesion caused by the presence of *Baylisascaris* sp. larva (arrowhead). H&E stain. Bar = 350 μm. 3. Photomicrograph of liver lesion caused by the presence of *Baylisascaris* sp. larva (arrowheads). H&E stain. Bar = 350 μm. 4. Higher magnification of *Baylisascaris* sp. larva from liver showing the lateral alae and characteristically laterally compressed intestinal lumen (arrowhead). H&E stain. Bar = 20 μm. 5. Female *Dracunculus* sp. in situ on musculature of the lateral abdomen.

kg, both taken from the same locality (Wildcat Creek, Riley County), were found to harbor 4 and 1 fertile adult female *Dracunculus* sp., respectively. Lengths in millimeters, from 3 intact female nematodes, were as follows: 220, 210, and 185. In the smaller beaver, parasites were located bilaterally under the latissimus dorsi muscle. The single *Dracunculus* sp. present in the other animal was visible through the fascia of the external abdominal oblique muscle of the lateral abdomen (Fig. 5). Because only female worms were found, we were unable to make a specific identification.

Neither *Baylisascaris* sp. or *Dracunculus* sp. has been reported previously from North American beaver. The only reference to *Baylisascaris* sp. in beaver appears to be that of Kelly and Innes (1966). They reported the impossibility of raising infant beavers, *C. canadensis,* to maturity at the Dublin Zoological Gardens in Dublin, Ireland. They described clinical signs of motor weakness and progressive incoordination in an entire litter within 2 wk of birth. Histopathological examination of the brain of an affected individual revealed areas of patchy encephalitis and perivascular cuffing as well as cross-sections of 2 nematode larvae, identified only as "ascarids." A photomicrograph of a cross-section of 1 of the larvae clearly shows the intestinal lumen to be laterally compressed, a key character for the identification of the larvae as *Baylisascaris* sp. (Bowman, 1987).

Sprent (1968) and Kazacos and Boyce (1989) have listed several North American species of the genus *Baylisascaris* that may cause larval migrants in various avian and mammalian hosts. Among them are *B. columnaris* in skunks, *B. devosi* in fishers and martens, *B. melis* in badgers, *B. procyonis* in raccoons, and *B. transfuga* in bears. Larval identification beyond the generic level is impossible for *Baylisascaris* spp. The 2 most likely possibilities for the larvae found in this particular beaver are *B. columnaris* or *B. procyonis,* as both striped skunks (*Mephitis mephitis*) and raccoons (*Procyon lotor*) are common throughout the state (Bee et al., 1981).

Various mammals have been reported as definitive hosts for *Dracunculus* spp. in the United States and Canada (Muller, 1971; Crichton and Beverley-Burton, 1974). With 2 exceptions, the muskrat (*Ondatra zibethicus*) and the opossum (*Didelphis* sp.), all reported hosts have been of the order Carnivora. With our findings, the beaver becomes the second naturally occurring rodent host for this parasite. While no exact figures are available for Kansas, the occurrence of *Dracunculus insignis,* particularly in raccoons, is a relatively common finding in North America (Crichton and Beverley-Burton, 1977; Tumlison et al., 1984) and has also been reported from dogs in the state (Ewing and Hibbs, 1966; Veatch and McKown, 1990). A specific determination cannot be made until males are collected.

The earliest report of coccidia in beaver from North America comes from Morley (1934), who reported oocysts in the large intestine of a beaver from Pennsylvania. During the same year, Yakimoff (1934) described and named *E. sprehni* from a captive North American beaver. To our knowledge, no other studies reporting coccidia in *C. canadensis* exist or were published until Ernst et al. (1970) gave a redescription of *E. sprehni* and provided a description of a new coccidian, *Eimeria causeyi.* To date, coccidia from only 4 regions in North America, Alabama (Ernst et al., 1970), Pennsylvania (Morley, 1934), Washington (Frost et al., 1980), and Kansas (this study), have been reported. We feel that the paucity of reports come not from the rarity of the parasite but, rather, from the lack of investigation.

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